WCSP-Packaged bq24160/161/163/168 Evaluation Module

The bq24160/161/163/168 evaluation module is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode charge management solution for single-cell, Li-ion and Li-polymer batteries used in a wide range of portable applications.

Contents

List of Figures

List of Tables

I^2C is a trademark of Philips Electronics N.V.

1 Introduction

1.1 bq2416x IC Features

The bq24160/161/163/168 integrates a synchronous PWM controller, power MOSFETs, input-current sensing, high-accuracy current and voltage regulation, charge termination and power path management into a small WCSP package. The charge parameters can be programmed through an I^2C interface. Key IC features include:

- High-efficiency, fully integrated, NMOS-NMOS, synchronous buck charger with 1.5-MHz frequency
- Integrated power FETs for up to 2.5-A charge rate
- Power path management between battery and system voltages

For details, see the bq24160/161/163/168 data sheet (SLUSAO0).

1.2 bq24160/161/163/168 EVM Features

The bq24160/161/163/168 evaluation module (EVM) is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode battery charge and power path management solution for single-cell, Li-ion and Li-polymer battery-powered systems used in a wide range of portable applications. Key EVM features include:

- 153-mm × 153-mm × 1.2-mm footprint for entire solution
- Input power connectors for both USB input and ac adapter
- Programmable battery voltage, charge current, input current, and status via I^2C™ interface
- IN operating range of 4.2 V – 10 V (bq24160/161/163) or 4.2 V – 6 V (bq24168)
- USB operating range of 4.2 V – 6 V
- LED indication for status signals
- Test points for key signals available for testing purposes. Easy probe hook-up

1.3 Schematic

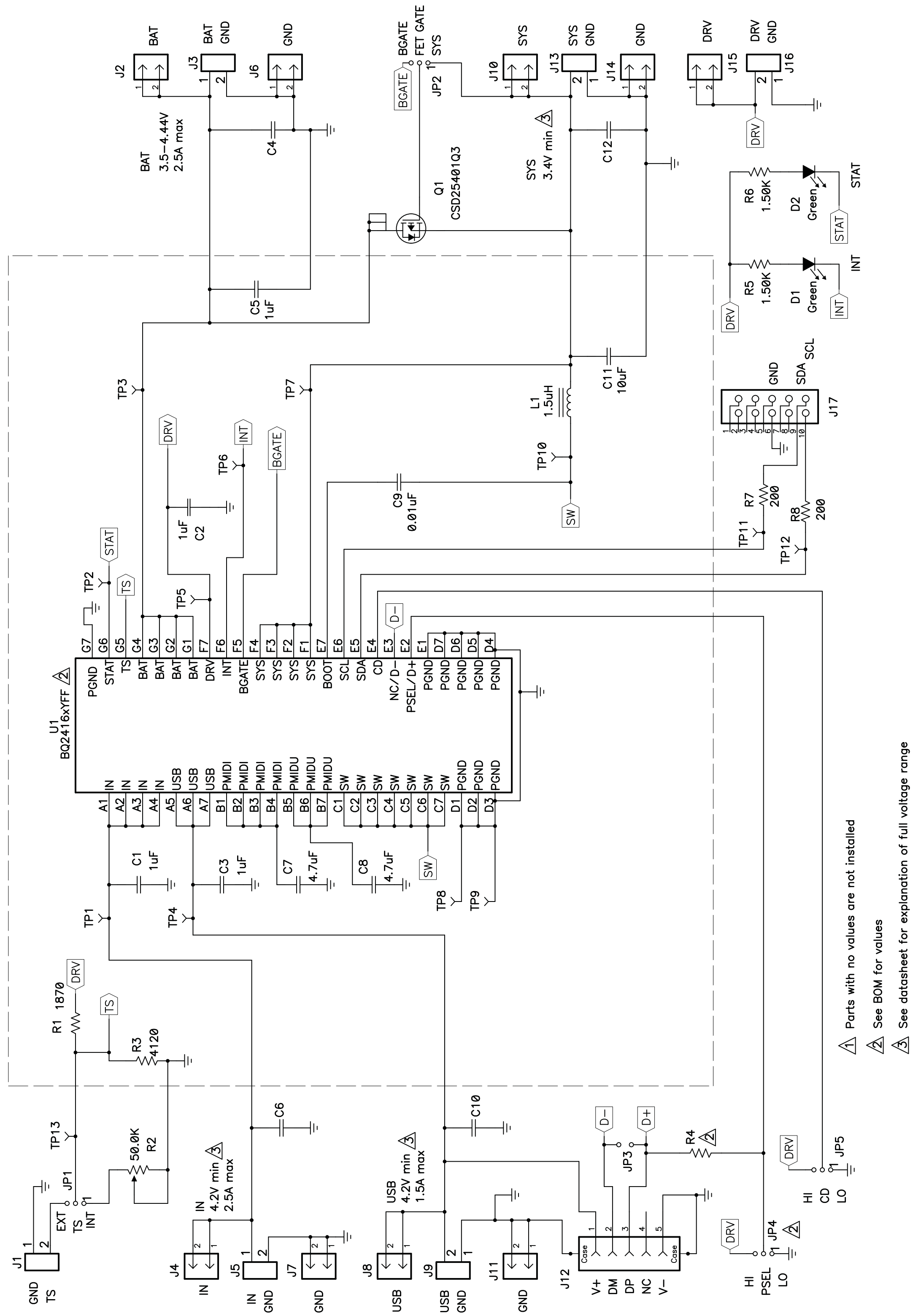

Figure 1. bq24160/161/163/168EVM (HPA721) Schematic

NOTE: EVMs with a printed-circuit board label that contain the suffix *-X* may have been assembled with incorrectly marked ICs. Regardless of the IC's marking, the EVM was assembled with the correct part number as specified in the EVM bill of material.

1.4 I/O Description

Header/Terminal Block	Description
J1–TS	External thermistor positive terminal
J1–GND	Ground terminal for external thermistor
J2–BAT	Battery positive header
J3-BAT	Battery positive terminal
J3-GND	Battery negative terminal
J4-IN	Adapter positive header
J5-IN	Adapter positive terminal
J5-GND	Adapter negative terminal
J6-GND	Battery negative terminal
J7-GND	Adapter negative terminal
J8-USB	USB positive header
J9-USB	USB positive terminal
J9-GND	USB negative terminal
J10-SYS	System output positive header
J11-GND	USB negative header
J12	USB Miniconnector
J13-SYS	System output positive terminal
J13-GND	System output negative terminal
J14-GND	System output negative header
J15-DRV	DRV reference voltage positive header
J16-DRV	DRV reference voltage positive terminal
J16-GND	DRV reference voltage negative terminal
J17	USB-TO-GPIO box connector

1.5 Test Points

Test Point	Description
TP1	Kelvin to VIN
TP2	STAT
TP3	Kelvin to BAT
TP4	Kelvin to USB
TP5	DRV
TP6	INT
TP7	Kelvin to SYS
TP8	GND
TP9	GND
TP10	SW
TP11	SCL
TP12	SDA
TP13	TS

1.6 Control and Key Parameters Setting

Jumper	Description	Default Factory Setting
JP1	1-2 (TS = INT): Connects a potentiometer to the TS so that the potentiometer can emulate a thermistor. The potentiometer has been preset to approximately 3.4 kΩ so that the TS voltage is 0.5 x V (DRV). 2-3 (TS = EXT): Connects the TS pin to an external thermistor. The resistor divider formed by R1 and R3 has been sized to accommodate a 10-kΩ thermistor. If a different thermistor is used, R1 and R3 must be resized.	1-2 (TS = INT)
JP2	1-2 (FET GATE = SYS): External PFET's gate tied to SYS and therefore disabled. 2-3 (FET GATE = BGATE): External PFET's gate tied to BGATE pin and therefore controlled by IC.	2-3 (FET GATE = BGATE)
JP3	Shorting jumper for USB data lines DM (D-) and DP (D+). When shorted, USB input current limit defaults to 1.5 A. Otherwise, USB100 mode is selected.	SHORTED
JP4	bq24161 and bq24162A only 1-2 (PSEL = LO): Indicates that an ac adapter is connected to the USB input and sets the USB input current limit to 1.5 A. 2-3 (PSEL = HI): Indicates that a USB source is connected to the USB input and sets the input current limit to 500 mA.	2-3 (PSEL = HI)
JP5	1-2 (CD = LO): Charge disable low for normal operation 2-3 (CD = HI): Charge disable high to disable charge and enter Hi-Z mode	1-2 (CD = LO)

1.7 Recommended Operating Conditions

		Min	Typ	Max	Unit
Supply voltage, V_{IN}	Input voltage from ac adapter (bq24160/161/163)	4.2		10	V
Supply voltage, V_{IN}	Input voltage from ac adapter (bq24168)	4.2		6	V
USB voltage, V_{USB}	Input voltage from USB or equivalent supply	4.2		6	V
System voltage, V_{SYS}	Voltage output at SYS terminal (bq24160/161/168; depends on VBAT voltage and status of V_{INDPM})	3.3		VBATREG+4.17%	V
System voltage, V_{SYS}	Voltage output at SYS terminal (bq24163; depends on VBAT voltage and status of V_{INDPM})	3.1		VBATREG+4.17%	V
Battery voltage, V_{BAT}	Voltage output at VBAT terminal (registers set via I2C communication)	3	4.2	4.44	V
Supply current, $I_{IN(MAX)}$	Maximum input current from ac adapter input (registers set via I2C communication)	1.5		2.5	A
Supply current, $I_{USB(MAX)}$	Maximum input current from USB input (registers set via I2C communication)	0.1	0.5	1.5	A
Fast charge current, $I_{CHRG(MAX)}$	Battery charge current (registers set via I2C communication)	0.550		2.5	A
Operating junction temperature range, T_J		-40		125	°C

2 Test Summary

This procedure describes one test configuration of the HPA721 evaluation board for bench evaluation.

2.1 Definitions

The following naming conventions are followed.

VXXX :	External voltage supply name (VADP, VBT, VSBT)
LOADW:	External load name (LOADR, LOADI)
V(TPyyy):	Voltage at internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
V(Jxx):	Voltage at header Jxx

V(TP(XXX)):	Voltage at test point XXX. For example, V(ACDET) means the voltage at the test point which is marked as ACDET.
V(XXX, YYY):	Voltage across point XXX and YYY.
I(JXX(YYY)):	Current going out from the YYY terminal of header XX.
Jxx(BBB):	Terminal or pin BBB of header xx.
JPx ON :	Internal jumper Jxx terminals are shorted.
JPx OFF:	Internal jumper Jxx terminals are open.
JPx (-YY-)	ON: Internal jumper Jxx adjacent terminals marked as YY are shorted.
Measure: → A,B	Check specified parameters A, B. If measured values are not within specified limits, the unit under test has failed.
Observe → A,B	Observe if A, B occur. If they do not occur, the unit under test has failed.

Assembly drawings have location for jumpers, test points, and individual components.

2.2 Recommended Test Equipment

2.2.1 Power Supplies

1. Power Supply #1 (PS #1) capable of supplying 6 V at 3 A is required.
2. If not using a battery as the load, then power supply #2 (PS #2) capable of supplying up to 5 V at 5 A is required to power the circuit shown in Figure 2.

2.2.2 Load #1 Between BAT and GND

Testing with an actual battery is the best way to verify operation in the system. If a battery is not available, then a battery or circuit similar to the one shown inFigure 2 can simulate a battery when connected to a power supply.

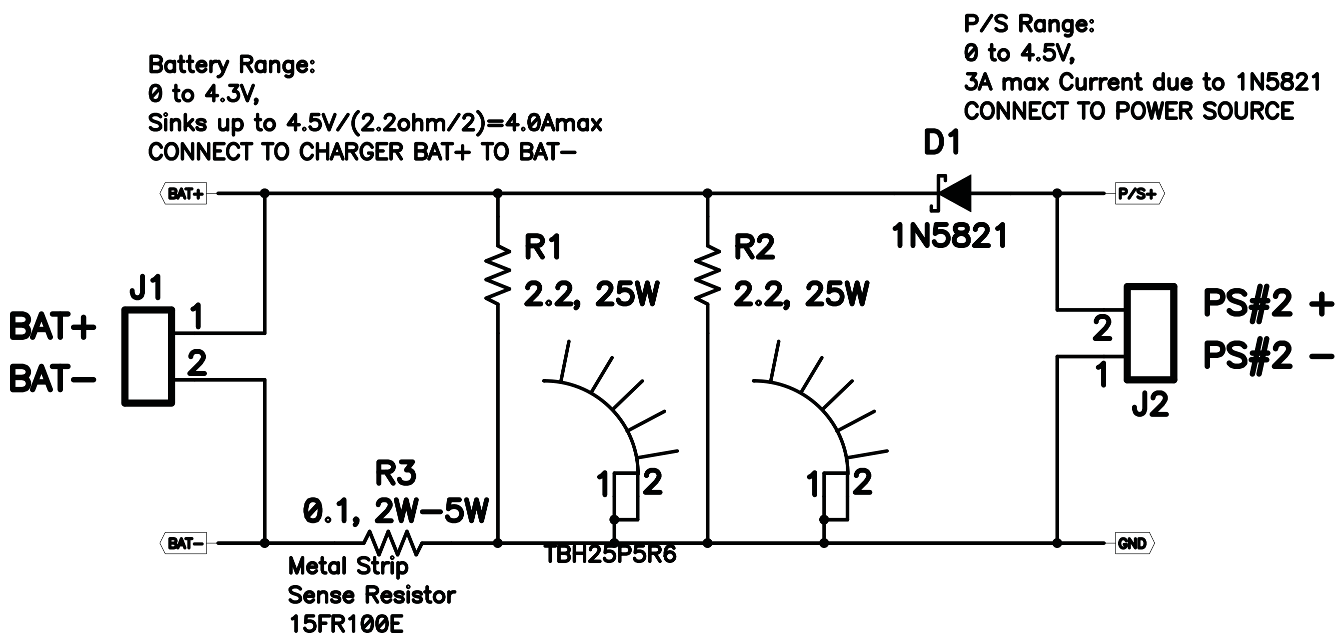

Figure 2. BAT_Load (PR1010) Schematic

2.2.3 Load #2 Between SYS and GND

Although not required, a resistive load capable of sinking up to 3 A can be used.

2.2.4 Meters

Four equivalent voltage meters (VM #) and two equivalent current meters (CM #) are required. The current meters must be able to measure 3-A current.

2.2.5 Computer

A computer with at least one USB port and a USB cable is required. The bq2416x evaluation software must be properly installed.

2.2.6 HPA172 Communication Kit (USB TO GPIO)

A HPA172 USB-to-I^2C communication kit is required.

2.2.7 Software

Download BQ2416xSW.zip from the charger's product folder, unzip the file, and double-click on the SETUP.EXE file. Follow the installation steps.

Because the bq24160, bq24161, and bq24163 have the watchdog timers enabled, it is recommended that you set the software's **Reset Watchdog Timer** to reset every 5 seconds. Otherwise, after 30 seconds of operation, the IC enters Default mode. Note that the 27-minute safety timer is not reset by this function and eventually times out if charging does not complete, unless the **Safety Timer Time Limit** is expanded or disabled via the GUI. One way to reset the safety timer is to allow the 30-second watchdog timer to expire. See Figure 3 in the data sheet for more information about the timers.

Also, it is generally helpful to activate the **Write On Change** functions, in the upper left of the GUI window, to ON. The Write On Change function writes any changes to the GUI's check boxes, drop-down boxes, and registers to the IC. Otherwise, the user must click the **WRITE** button to write changes to the software. It is recommended that the user periodically click the **READ** button to find the IC's instantaneous status. Alternatively, the **AutoRead** function can be activated to periodically update the GUI with the IC's status.

2.3 Recommended Test Equipment Setup

1. For all power connections, use short, twisted-pair wires of appropriate gauge wire for the amount of the current.
2. Set Power Supply #1 (PS #1) for 6-V, 3-A current limit and then turn off supply.
3. If BAT_Load is the circuit shown in Figure 1, connect Power Supply #2 (PS #2) set to approximately 3.6 V to the input side (PS #2+/-) of BAT_Load, then turn off PS #2.
4. Connect the output side of the battery or BAT_Load in series with current meter (multimeter) #2 (CM #2) to J2 and J6 or J3 (BAT, GND). Ensure that a voltage meter is connected across J2 or TP3 and J6 or TP9 (BAT, GND).
5. Connect VM #3 across J10 or TP7 and J14 or TP9 (SYS, GND).
6. Connect VM #4 across J15 or TP5 and J14 or TP9 (DRV, GND).
7. Connect J17 to HPA172 kit by the 10-pin ribbon cable. Connect the USB port of the HPA172 kit to the USB port of the computer. The connections are shown in Figure 3.

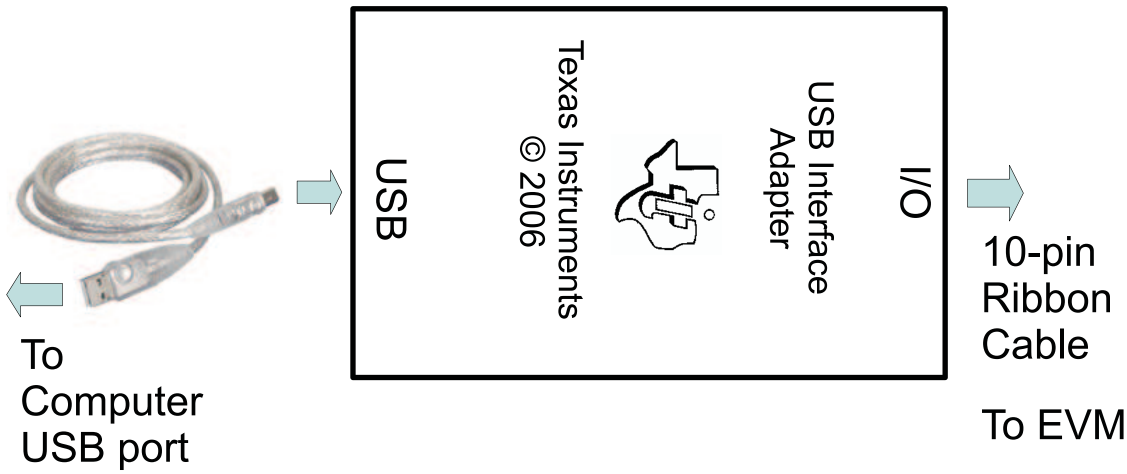

Figure 3. Connections of HPA172 Kit

8. Ensure jumpers are at the default factory settings per Section 1.6
9. After the preceding steps have been performed, the test setup for HPA721 is configured as is shown in Figure 4

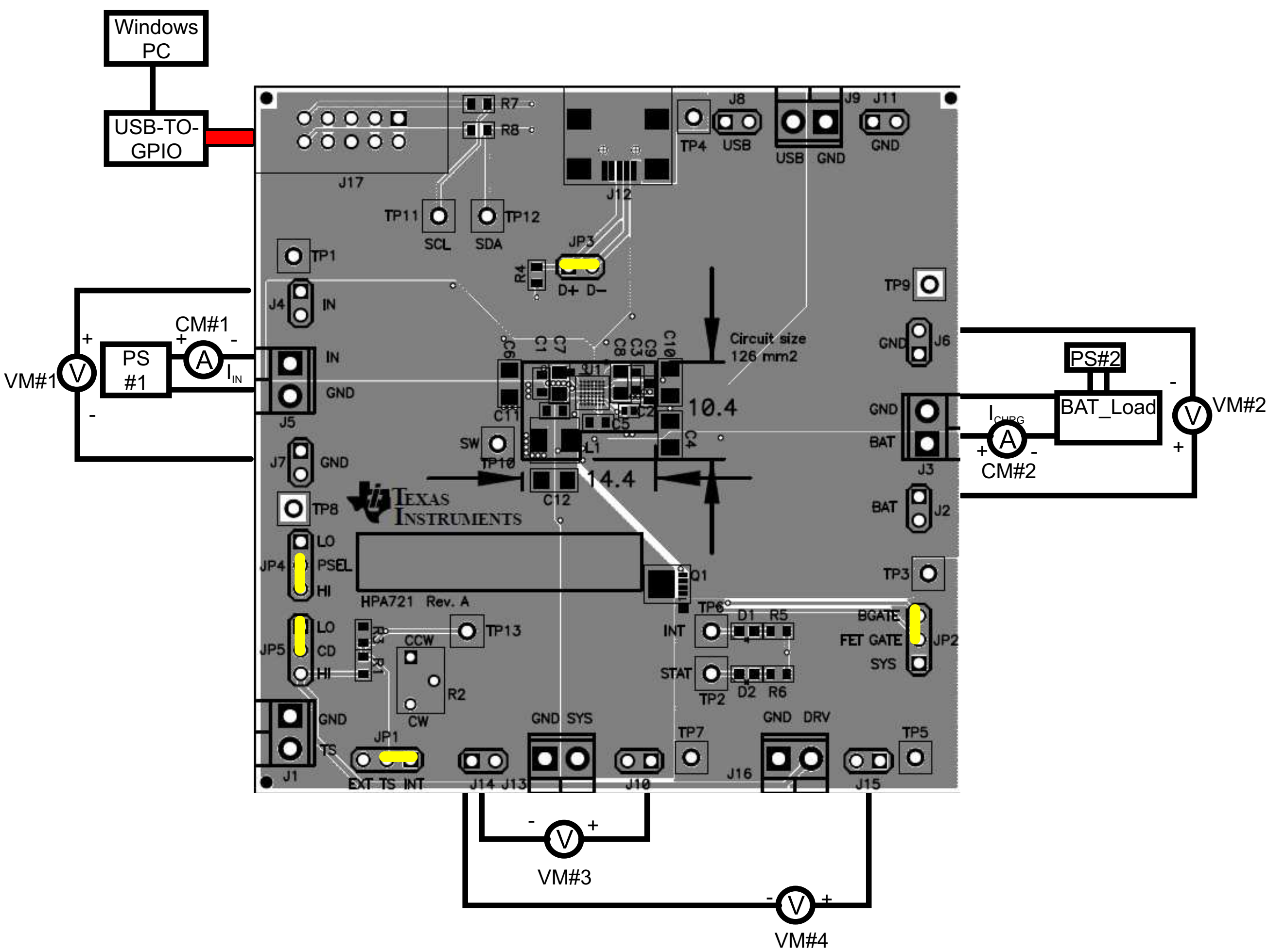

Figure 4. Original Test Setup for bq24160/161/163/168EVM (HPA721)

10. Turn on the computer. Open the bq2416x evaluation software. The main window of the software is shown in Figure 5

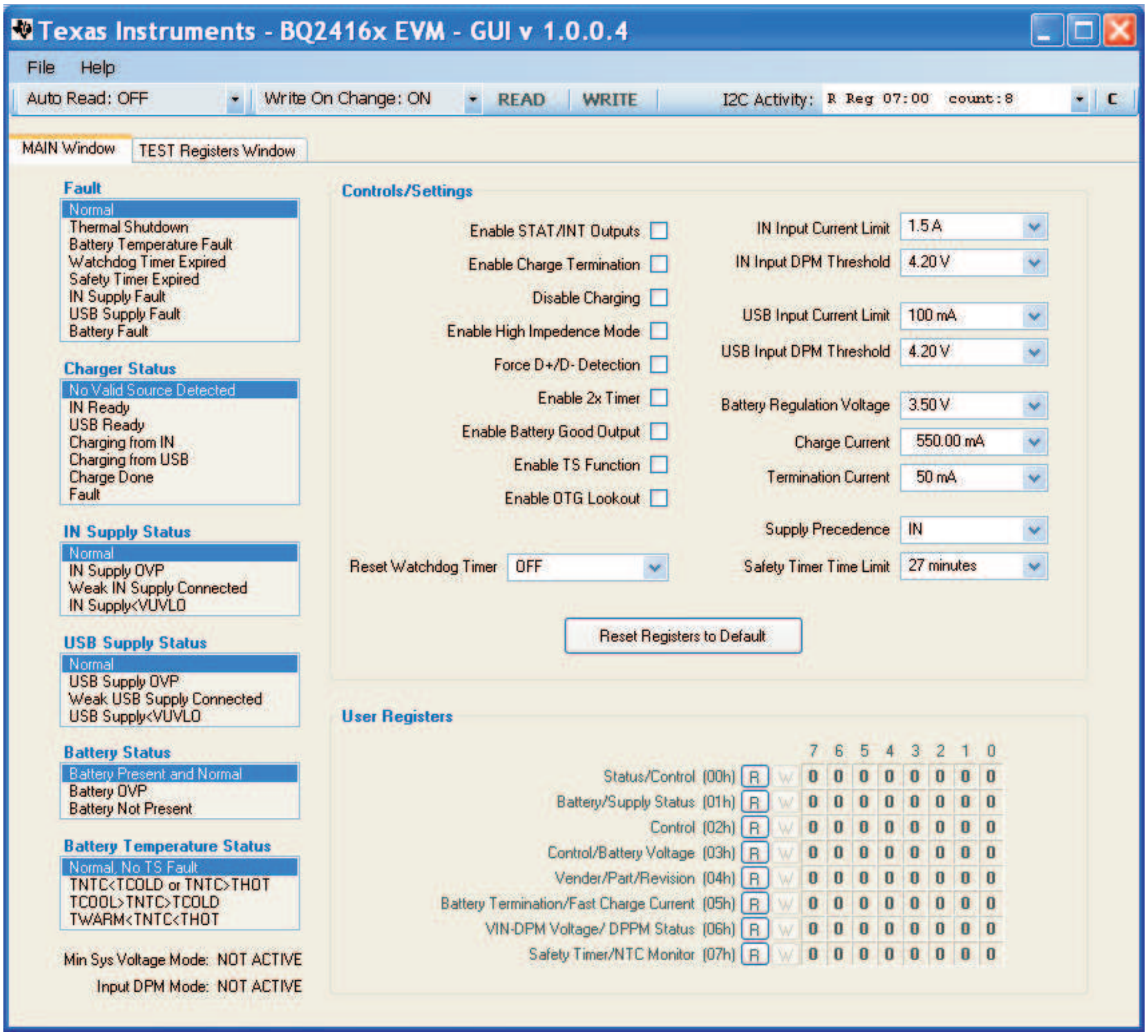

Figure 5. Main Window of bq2416xSW Evaluation Software

2.4 Recommended Test Procedure

The following test procedure may be useful for evaluating the charger IC outside of a real system, if no battery is available to connect to the output and a simulated battery if needed.

2.4.1 Charge Voltage and Current Regulation of IN

1. Ensure that the Section 2.3 steps are followed.
2. Connect the output of Power Supply #1 (PS #1) in series with current meter (multimeter) #1 (CM #1) to J4 and J7 or J5 (IN, GND).
3. Connect voltage meter 1 (VM #1) across J4 or TP1 and J7 or TP8 (IN, GND).
4. Move JP5 to HI.
5. Turn on PS #1 and PS #2 if used.
6. Return JP5 to LO.
7. Software setup:
   - Press the **READ** button to obtain the current settings.

- Set **Write On Change** to ON if not already set.
- Set **Reset Watchdog Timer** to update every 5 seconds.
- Set **Supply Precedence** to IN if not already set.
- Uncheck **Disable Charging** if checked.
- Check **Enable STAT/INT Outputs**.
- Set **Battery Regulation Voltage** to 4.20 V.
- Set **IN Input Current Limit** to 2.5 A.
- Set **Charge Current** to 1000 mA.
- Click the **READ** button at the top of the window and confirm that the previous settings remain.

8. For the bq24160 EVM, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 3.2 V ± 50 mV. For the bq24161/163/168 EVMs, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 2.5 V ± 50 mV.
9. Adjust the power supply so that VM #1 still reads 6 V ± 100 mV, if necessary, then

   Measure on CM#2 → I_{CHRG} = 1000 mA ± 100 mA

   Measure on CM#1 → I_{IN} = 700 mA ± 70 mA
10. Turn off PS #1 and PS #2.

2.4.2 Charge Voltage and Current Regulation of USB

1. Ensure that the Section 2.3 steps are followed.
2. Connect the output of Power Supply #1 (PS #1) in series with current meter (multimeter) #1 (CM #1) to J8 and J11 or J9 (USB, GND).
3. Connect a voltage meter 1 (VM #1) across J8 or TP4 and J11 or TP8 (USB, GND).
4. Move JP5 to HI.
5. Turn on PS #1 and PS #2 if used.
6. Return JP5 to LO.
7. Software setup:
   - Press the **READ** button to obtain the current settings.
   - Set **Write On Change** to ON if not already set.
   - Set **Reset Watchdog Timer** to update every 5 seconds.
   - Set **Supply Precedence** to USB if not already set.
   - Uncheck **Disable Charging** if checked.
   - Check **Enable STAT/INT Outputs**.
   - Set **Battery Regulation Voltage** to 4.20 V.
   - Set **USB Input Current Limit** to 1500 mA.
   - Set **Charge Current** to 1000 mA.
   - Click the **READ** button at the top of the window, and confirm that the previous settings remain.
8. For the bq24160 EVM, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 3.2 V ± 50 mV. For the bq24161/163/168 EVMs, enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 2.5 V ± 50 mV.
9. Adjust the power supply so that VM #1 still reads 6 V ± 100 mV if necessary then

   Measure on CM#2 → I_{CHRG} = 1000 mA ± 100 mA

   Measure on CM#1 → I_{IN} = 700 mA ± 70 mA
10. Turn off PS #1 and PS #2.

2.4.3 Helpful hints

1. To observe the taper current as the battery voltage approaches the set regulation voltage, allow the battery to charge or, if using BAT_Load (PR1010), slowly increase the PS #2 voltage powering BAT_Load (PR1010). Use VM #2 across BAT and GND to measure the battery voltage seen by the IC.

2. To observe the V_{INDPM} function, lower the current limit on PS #1.
3. To observe battery supplement mode, apply a resistive load across SYS and GND that is higher than the maximum charge current.

3 Printed-Circuit Board Layout Guideline

1. To obtain optimal performance, the power input capacitors, connected from the PMID input to PGND, must be placed as close as possible to the bq2416x
2. Place 4.7-μF input capacitor as close to PMID pin and PGND pin as possible to make the high-frequency current loop area as small as possible. Place 1-μF input capacitor GNDs as close to the respective PMID capacitor GND and PGND pins as possible to minimize the ground difference between the input and PMID_.
3. The local bypass capacitor from SYS to GND must be connected between the SYS pin and PGND of the IC. The intent is to minimize the current path loop area from the SW pin through the LC filter and back to the PGND pin.
4. Place all decoupling capacitors close to their respective IC pins and as close as to PGND (do not place components such that routing interrupts power stage currents). All small control signals must be routed away from the high-current paths.
5. The PCB must have a ground plane (return) connected directly to the return of all components through vias (two vias per capacitor for power-stage capacitors, one via per capacitor for small-signal components). It is also recommended to put vias inside the PGND pads for the IC, if possible. A star ground design approach is typically used to keep circuit block currents isolated (high-power/low-power small-signal) which reduces noise-coupling and ground-bounce issues. A single ground plane for this design gives good results. With this small layout and a single ground plane, no ground-bounce issue exists, and having the components segregated minimizes coupling between signals.
6. The high-current charge paths into IN, USB, BAT, SYS, and from the SW pins must be sized appropriately for the maximum charge current in order to avoid voltage drops in these traces. The PGND pins must be connected to the ground plane to return current through the internal low-side FET.
7. For high-current applications, the balls for the power paths must be connected to as much copper in the board as possible. This allows better thermal performance because the board conducts heat away from the IC.

4 Bill of Materials and Board Layout

4.1 Bill of Materials

Table 1. Bill of Materials - HPA721

Count				RefDes	Value	Description	Size	Part Number	MFR
-001	-002	-003	-004						
2	2	2	2	C1, C3	1 µF	Capacitor, Ceramic, 25V, X5R, 10%	603	Std	Std
2	2	2	2	C2, C5	1 µF	Capacitor, Ceramic, 6.3V, X5R, 10%	402	Std	Std
1	1	1	1	C4, C12	47 µF	Capacitor, Ceramic, 6.3V, X5R, 10%	1206	Std	Std
0	0	0	0	C6, C10	Open	Capacitor, Ceramic	1206	Std	Std
2	2	2	2	C7, C8	4.7 µF	Capacitor, Ceramic, 25V, X5R, 10%	805	Std	Std
1	1	1	1	C9	0.01 µF	Capacitor, Ceramic, 16V, X7R, 10%	603	Std	Std
1	1	1	1	C11	10 µF	Capacitor, Ceramic, 10V, X5R, 10%	603	Std	Std
2	2	2	2	D1, D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	603	LTST-C190GKT	Liteon
6	6	6	6	J1, J3, J5, J9, J13, J16	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED555/2DS	OST
1	1	1	1	J12	UX60-MB-5ST	Connector, Recpt, USB-B, Mini, 5-pins, SMT	0.354 X 0.303 Inches	UX60-MB-5ST	Hiroise Electrical Co
1	1	1	1	J17	N2510-6002-RB	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 x 0.788 inch	N2510-6002-RB	3M
9	9	9	9	J2, J4, J6, J7, J8, J10, J11, J14, J15	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
3	3	3	3	JP1, JP2, JP5	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	1	1	1	JP3	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
0	1	1	0	JP4	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	1	1	1	L1	1.5µH	Inductor, SMT, 3.5A, 70 mW	4.1x4.4 mm	SPM4012T-1R5M Alternate: FDSD0415-H-1R5M	TD Alternate: Toko
1	1	1	1	Q1	CSD25401Q3	MOSFET, PChan, -20V, 60A, 8.7 mΩ	QFN3.3X3.3mm	CSD25401Q3	TI
1	1	1	1	R1	1870	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	1	1	R2	50.0k	Potentiometer, 3/8 Cermet, 12-Turn	0.25x0.17 inch	3266W-1-503LF	Bourns
1	1	1	1	R3	4120	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	0	0	1	R4	0	Resistor, Chip, 1/16W, 1%	603	Std	Std
2	2	2	2	R5, R6	1.50K	Resistor, Chip, 1/16W, 1%	603	Std	Std
2	2	2	2	R7, R8	200	Resistor, Chip, 1/16W, 1%	603	Std	Std
8	8	8	8	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP10	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
2	2	2	2	TP8, TP9	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
3	3	3	3	TP11, TP12, TP13	5002	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	0	0	1	U1	BQ24160YFF	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24160YFF	TI

Table 1. Bill of Materials - HPA721 (continued)

Count				RefDes	Value	Description	Size	Part Number	MFR
-001	-002	-003	-004						
0	1	0	0	U1	BQ24161YFF	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24161YFF	TI
0	0	1	0	U1	BQ24168YFF	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24168YFF	TI
0	0	0	1	U1	BQ24163YFF	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24163YFF	TI
4	5	5	4	—		Shunt, 100-mil, Black	0.100	929950-00	3M

4.2 Board Layout

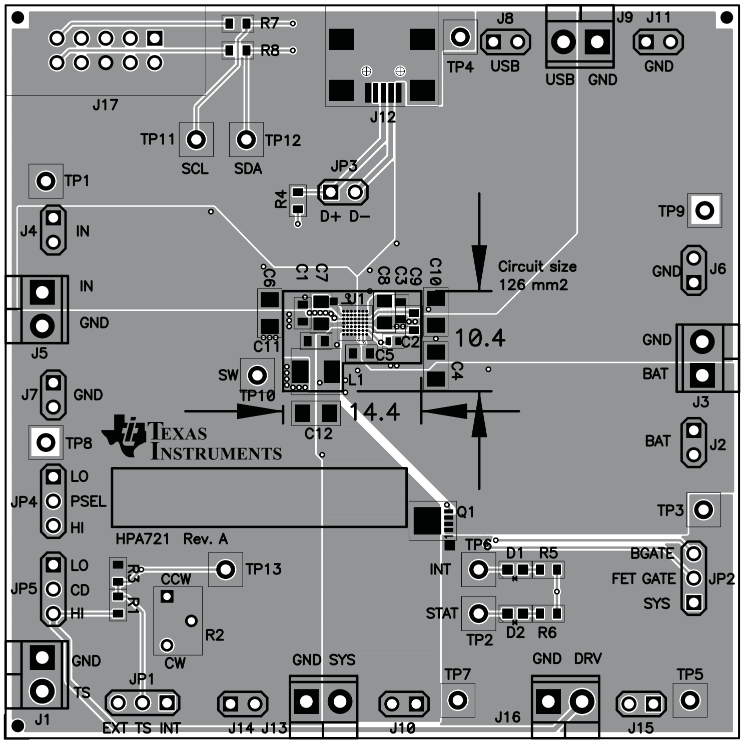

Figure 6. Top Assembly Layer

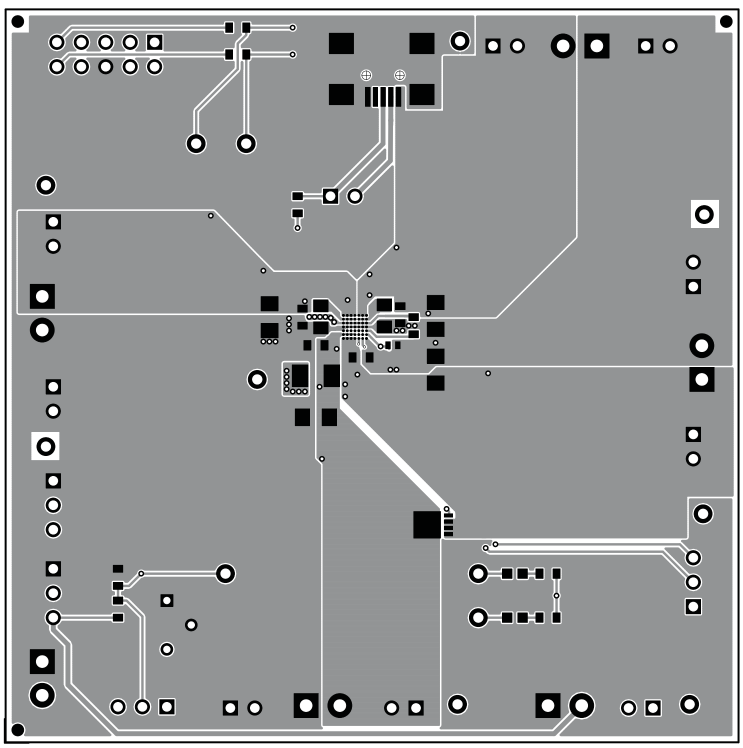

Figure 7. Top Layer

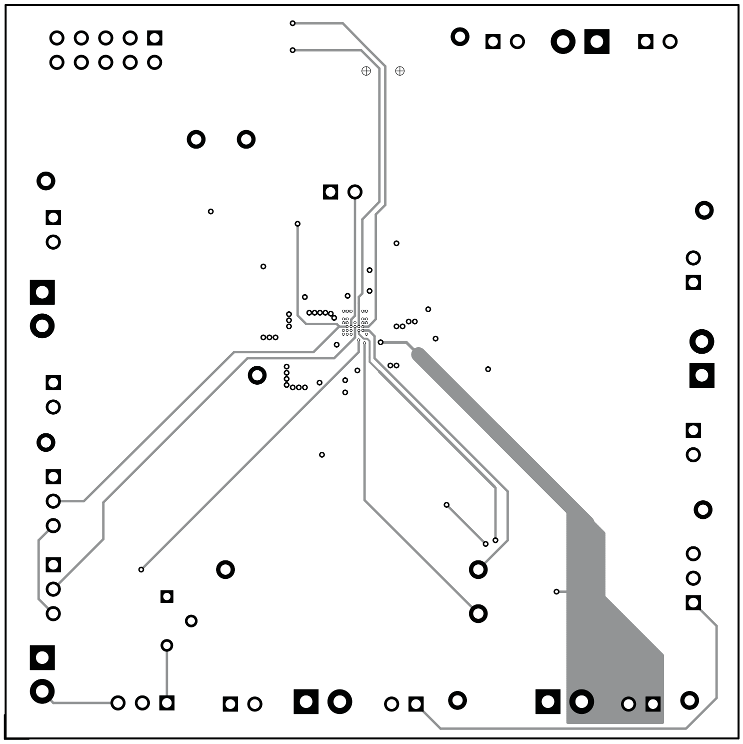

Figure 8. First Internal Layer

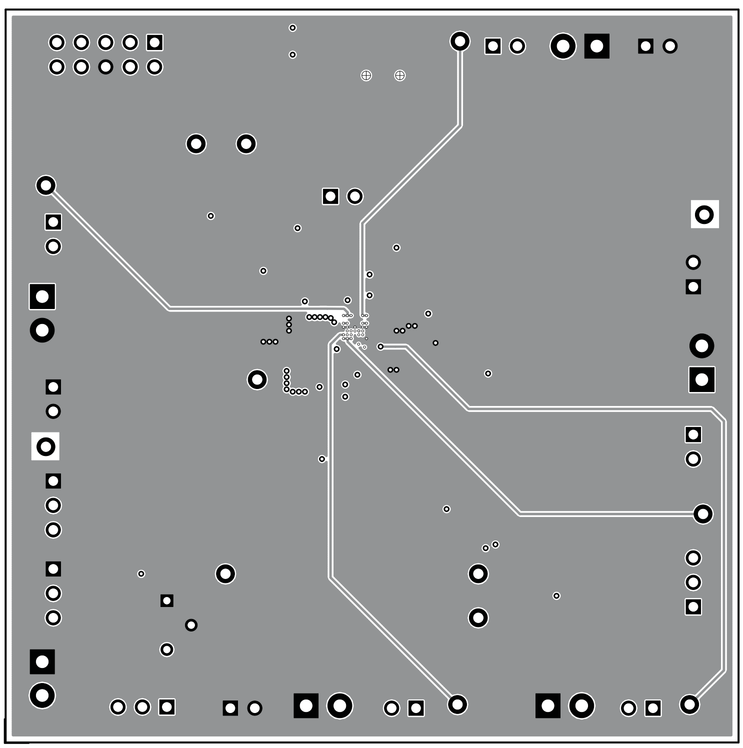

Figure 9. Second Internal Layer

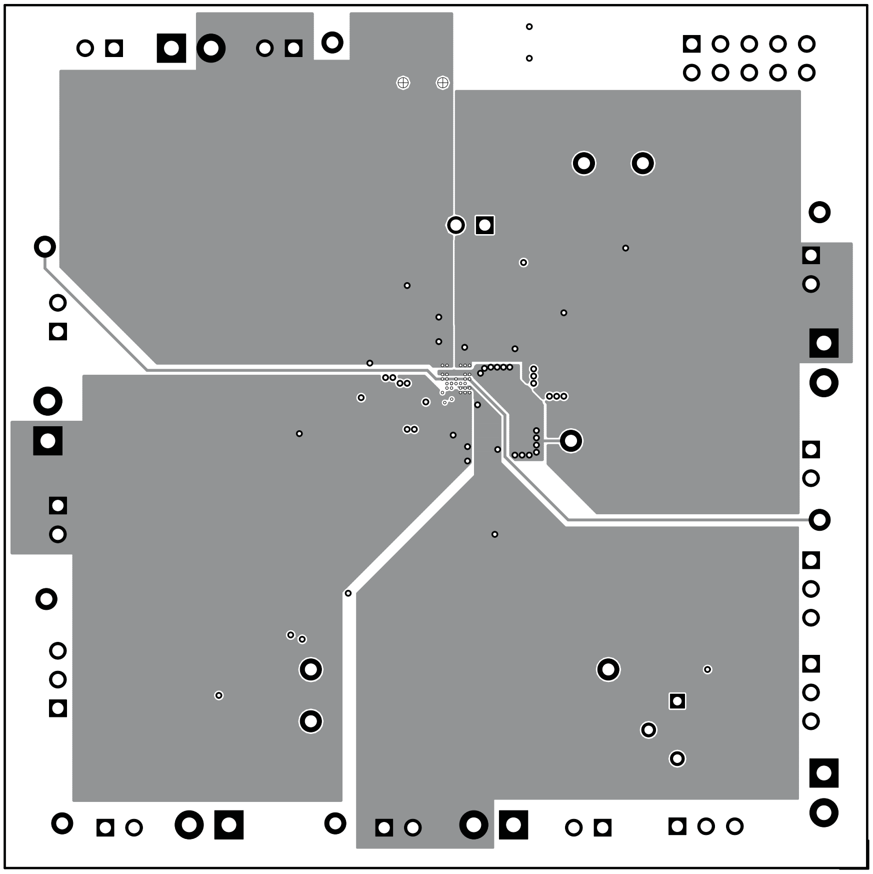

Figure 10. Bottom Layer

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 4 V to 6 V and the output voltage range of 0 V to 4.44 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 65°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265